

What Is Claimed Is:

1        1. An intraoperative neural monitoring system comprising  
2              a power source; and  
3              a stimulator powered by said power source to deliver a complete cycle of  
4              biphasic electrical stimulation for application to anatomical tissue, said stimulator  
5              delivering said complete cycle of biphasic electrical stimulation as a first group of  
6              a selected number of positive or negative pulses automatically followed by a  
7              second group of a selected number of pulses of reverse polarity to said pulses of  
8              said first group.

1        2. The intraoperative neural monitoring system recited in claim 1  
2              wherein said stimulator is powered by said power source to alternatively deliver a  
3              complete cycle of monophasic electrical stimulation for application to anatomical  
4              tissue and said stimulator delivers said complete cycle of monophasic electrical  
5              stimulation as a selected number of positive or negative pulses.

1        3. The intraoperative neural monitoring system recited in claim 2  
2              wherein said first group of pulses is selectable as being positive or negative and  
3              said pulses of said complete cycle of monophasic electrical stimulation are  
4              selectable as being all positive or all negative.

1        4. The intraoperative neural monitoring system recited in claim 3  
2              wherein said pulses are selectable to have a current amplitude from 0 to 200  
3              mA.

1        5. The intraoperative neural monitoring system recited in claim 4  
2              wherein said current amplitude of said pulses of said second group is the same  
3              as said current amplitude of said pulses of said first group.

1        6. The intraoperative neural monitoring system recited in claim 4

2       wherein the number of said pulses in each of said first group and said second  
3       group is selectable to be 1 to 8 pulses and the number of said pulses in said  
4       complete cycle of monophasic electrical stimulation is selectable to be 1 to 8  
5       pulses.

1              7.       The intraoperative neural monitoring system recited in claim 6  
2       wherein the number of said pulses in said second group is the same as the  
3       number of said pulses in said first group.

1              8.       The intraoperative neural monitoring system recited in claim 4  
2       wherein said pulses are selectable to have a duration in the range of 100 to 500  
3       microseconds.

1              9.       The intraoperative neural monitoring system recited in claim 4  
2       wherein said complete cycle of biphasic electrical stimulation includes a  
3       predetermined fixed interval between said first group of pulses and said second  
4       group of pulses of about 2 seconds.

1              10.      The intraoperative neural monitoring system recited in claim 4  
2       wherein said complete cycle of biphasic electrical stimulation comprises a delay  
3       between successive pulses in each of said first group and said second group of  
4       pulses and said complete cycle of monophasic electrical stimulation includes a  
5       delay between successive pulses, said delay being selectable to be in the range  
6       of 2 to 4 milliseconds.

1              11.      The intraoperative neural monitoring system recited in claim 1  
2       wherein said power source comprises a power console electrically connectible to  
3       said stimulator.

1              12.      An intraoperative neural monitoring system comprising

2           a power source;

3           a stimulator powered by said power source to deliver a complete cycle of  
4           biphasic electrical stimulation for application to anatomical tissue, said stimulator  
5           delivering said complete cycle of biphasic electrical stimulation as a first group of  
6           one or more positive or negative pulses followed by a second group of one or  
7           more pulses of opposite polarity to said pulses of said first group; and

8           an activator actuatable by a user to complete an activation that starts  
9           delivery of said first group of pulses, said activation being effective to deliver said  
10          complete cycle of biphasic electrical stimulation.

1           13.   The intraoperative neural monitoring system recited in claim 12  
2           wherein said activator is actuatable to complete said activation in a two-step  
3           procedure performed by the user.

1           14.   The intraoperative neural monitoring system recited in claim 13  
2           wherein said activator comprises a hand switch.

1           15.   The intraoperative neural monitoring system recited in claim 13 and  
2           further comprising a power console electrically connected to said stimulator, said  
3           power console having a touch screen, and said activator comprises a control  
4           option on said touch screen.

1           16.   The intraoperative neural monitoring system recited in claim 12  
2           wherein said stimulator is powered by said power source to alternatively deliver a  
3           complete cycle of monophasic electrical stimulation for application to anatomical  
4           tissue, said stimulator delivering said complete cycle of monophasic electrical  
5           stimulation as one or more positive or negative pulses, and said activation is  
6           effective to deliver said complete cycle of monophasic electrical stimulation.

1           17.   An intraoperative neural monitoring system comprising

2           a power console providing a power source and a display screen;  
3           a patient interface unit electrically connectible to said power console, said  
4           patient interface unit being connectible to monitoring electrodes placed at areas  
5           of a patient's body to detect responses to a first form of electrical stimulation and  
6           a second form of electrical stimulation for display on said display screen, said  
7           patient interface unit being connectible to monopolar and bipolar stimulating  
8           probes for applying said first form of electrical stimulation to anatomical tissue of  
9           the patient, said patient interface unit delivering said first form of electrical  
10          stimulation up to a current amplitude of about 30mA; and

11           a stimulator electrically connectible to said power console, said stimulator  
12          being connectible to a pair of stimulating electrodes placed at areas of a patient's  
13          body for applying said second form of electrical stimulation to anatomical tissue  
14          of the patient, said stimulator delivering said second form of electrical stimulation  
15          to a first one of the stimulating electrodes for return via a second one of the  
16          stimulating electrodes in a positive phase for said second form of electrical  
17          stimulation and delivering said second form of electrical stimulation to the  
18          second one of the stimulating electrodes for return via the first one of the  
19          stimulating electrodes in a negative phase for said second form of electrical  
20          stimulation, said stimulator delivering said second form of electrical stimulation  
21          up to a current amplitude of about 200 mA.

1           18. The intraoperative neural monitoring system recited in claim 17  
2          wherein said first form of electrical stimulation comprises continuous constant  
3          current monophasic DC pulses and said second form of electrical stimulation  
4          comprises a cycle of a selectable number of constant current DC pulses, said  
5          cycle having a mode selectable as a monophasic cycle or a biphasic cycle.

1           19. The intraoperative neural monitoring system recited in claim 18  
2          wherein said pulses in said monophasic cycle are all of said positive phase or all  
3          of said negative phase, and said pulses in said biphasic cycle comprise a first

4 group of said pulses which are all of said positive phase or all of said negative  
5 phase followed by a second group of said pulses which are opposite in phase  
6 from said pulses of said first group.

1           20. The intraoperative neural monitoring system recited in claim 19  
2 wherein said pulses of said first form of electrical stimulation are selectable to  
3 have a pulse width in the range of 50 to 250 microseconds and a rate of 1 to 10  
4 pulses/second, said pulses of said second form of electrical stimulation are  
5 selectable to have a pulse width in the range of 100 to 500 microseconds, said  
6 number of pulses in said monophasic cycle is selectable to be in the range of 1  
7 to 8 pulses, said number of pulses in said biphasic cycle is selectable to be in  
8 the range of 1 to 8 pulses for said first group and an equal number of pulses for  
9 said second group, said biphasic cycle includes a fixed interval of about 2  
10 seconds between said first group and said second group of pulses, said biphasic  
11 cycle includes a delay between successive pulses in said first group and said  
12 second group, and said monophasic cycle includes said delay between  
13 successive pulses, and said delay is selectable to be in the range of 2 to 4  
14 milliseconds.

1           21. The intraoperative neural monitoring system recited in claim 20  
2 wherein said display screen comprises a touch screen presenting a plurality of  
3 displays including control options for selecting said pulse width, said current  
4 amplitude, said rate, said number of pulses, said delay and said mode.

5           22. The intraoperative neural monitoring system recited in claim 19 and  
6 further including an activator actuatable by a user for initiating delivery of said  
7 second form of electrical stimulation, wherein actuation of said activator to  
8 initiate delivery of said second form of electrical stimulation effects delivery of  
9 said monophasic cycle or said biphasic cycle in its entirety.

1           23. The intraoperative neural monitoring system recited in claim 19  
2 wherein said patient interface unit includes a plurality of monitoring channels  
3 each connectible to a pair of monitoring electrodes.

1           24. The intraoperative neural monitoring system recited in claim 23  
2 wherein said display screen includes a first monitoring display for displaying  
3 waveforms representing responses detected by the monitoring electrodes for  
4 each of said monitoring channels when said first form of electrical stimulation is  
5 applied to the patient and a second monitoring display for displaying waveforms  
6 representing responses detected by the monitoring electrodes for each of said  
7 monitoring channels when said second form of electrical stimulation is applied to  
8 the patient.

1           25. The intraoperative neural monitoring system recited in claim 24  
2 wherein said second monitoring display includes a waveform display area for  
3 simultaneously displaying responses detected by the monitoring electrodes in  
4 response to said first group and said second group of said pulses in said

5 biphasic cycle.

1           26. The intraoperative neural monitoring system recited in claim 24  
2 wherein said second monitoring display includes a waveform display area for  
3 simultaneously displaying responses detected by monitoring electrodes on the  
4 left and right sides of the patient's body.

1           27. The intraoperative neural monitoring system recited in claim 24  
2 wherein said touch screen includes a control option for selecting an event  
3 threshold by which detected responses above said event threshold are signaled.

1           28. The intraoperative neural monitoring system recited in claim 24  
2 wherein said touch screen includes a control option for setting an artifact delay  
3 by which the influence of artifact on detected responses is distinguished.

1           29. A method of intraoperative neural monitoring comprising the steps  
2 of  
3 activating a stimulator to initiate delivery of a biphasic cycle of electrical  
4 stimulation to a patient during an operative procedure;  
5 delivering the entire biphasic cycle of electrical stimulation to the patient in  
6 response to said activating step; and  
7 detecting electromyographic (EMG) activity in a muscle of the patient  
8 responsive to the electrical stimulation to monitor neural function during the

9 operative procedure.

1           30. The method of intraoperative neural monitoring recited in claim 29  
2 and further including the step of eliciting MEPs in the patient in response to the  
3 electrical stimulation.

1           31. The method of intraoperative neural monitoring recited in claim 30  
2 and further including the step of delivering an entire cycle of monophasic  
3 electrical stimulation from the stimulator in response to said activating step.

1           32. The method of intraoperative neural monitoring recited in claim 29  
2 wherein said step of activating comprises performing a two-step activation  
3 procedure via a touch screen of a power console that is connected with the  
4 stimulator.

1           33. The method of intraoperative neural monitoring recited in claim 29  
2 wherein said step of activating comprises performing a two-step activation  
3 procedure via a hand switch connected with a power console that is connected  
4 with the stimulator.

1           34. The method of intraoperative neural monitoring recited in claim 29  
2 wherein said step of detecting includes detecting EMG activity in limb muscles  
3 on the left and right sides of the patient's body.

4           35. The method of intraoperative neural monitoring recited in claim 34  
5       wherein said step of detecting includes detecting the EMG activity via monitoring  
6       electrodes placed in the muscles.

1           36. The method of intraoperative neural monitoring recited in claim 34  
2       wherein said step of delivering includes sequentially delivering the electrical  
3       stimulation to the left and right motor cortex of the patient.

1           37. The method of intraoperative neural monitoring recited in claim 34  
2       wherein said step of delivering includes delivering the electrical stimulation to the  
3       patient's spinal cord.

1           38. The method of intraoperative neural monitoring recited in claim 35  
2       wherein said step of delivering includes delivering the electrical stimulation to the  
3       patient via stimulating electrodes electrically connected to the stimulator and  
4       applied to the patient.

1           39. The method of intraoperative neural monitoring recited in claim 38  
2       and further comprising the steps of delivering continuous constant current  
3       electrical stimulation to the patient during the operative procedure via a  
4       stimulating probe in contact with anatomical tissue of the patient and evoking  
5       EMG activity in the patient in response to the electrical stimulation delivered via  
6       the probe, and wherein said step of detecting includes detecting EMG activity in

7           a muscle of the patient responsive to the electrical stimulation delivered via the  
8           probe to monitor neural function during the operative procedure.

1           40.     The method of intraoperative neural monitoring recited in claim 39  
2           wherein said step of delivering continuous constant current electrical stimulation  
3           comprises delivering the continuous constant current electrical stimulation to the  
4           probe from a patient interface unit electrically connected to a power console to  
5           which the stimulator is also electrically connected.

1           41.     The method of intraoperative neural monitoring recited in claim 39  
2           wherein said step of detecting comprises the step of continuously detecting EMG  
3           activity in the patient during the operative procedure.

1           42.     The method of intraoperative neural monitoring recited in claim 40  
2           and further comprising, prior to electrical stimulation, the steps of applying the  
3           monitoring electrodes to the patient in accordance with a montage display on a  
4           display screen of the power console, and confirming proper placement of the  
5           monitoring electrodes via an electrodes display on the display screen.

1           43.     The method of intraoperative neural monitoring recited in claim 42  
2           and further comprising, prior to electrical stimulation, the steps of selecting  
3           parameters for the electrical stimulation on the display screen.

1           44. The method of intraoperative neural monitoring recited in claim 43  
2 and further comprising the steps of selecting an artifact delay and event  
3 threshold on the display screen for the detected EMG activity.

1           45. The method of intraoperative neural monitoring recited in claim 44  
2 wherein said step of detecting includes displaying waveforms representative of  
3 the EMG activity on a monitoring display of the display screen and said step of  
4 displaying includes displaying measured current amplitude for the electrical  
5 stimulation on the monitoring display.

1           46. The method of intraoperative neural monitoring recited in claim 45  
2 wherein said step of displaying includes displaying waveforms representative of  
3 the EMG activity for positive and negative phases of the biphasic cycle of  
4 electrical stimulation simultaneously on a single monitoring display.